

and are made using a number of commercially available components, making them extremely inexpensive.

In the latest MXS design, UV efficiency is addressed by using a high-gain electron multiplier. The photocathode is vapor-deposited onto the input cone of a Burle Magnum™ multiplier. This system

yields an extremely robust photon-driven electron source that can tolerate long — weeks or more — exposure to air with negligible degradation. The package is also small. When combined with the electron target, necessary vacuum fittings, and supporting components (but not including LED electron-

ics or high-voltage sources), the entire modulated x-ray source weighs as little as 158 grams.

*This work was done by Keith Gendreau, Zaven Arzoumanian, Steve Kenyon, and Nick Spartana of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16287-1*

## Hollow-Fiber Spacesuit Water Membrane Evaporator

**Commercial applications include personal coolers for infantry, humidifiers for pilots, and personal coolers for hazmat suits.**

*Lyndon B. Johnson Space Center, Houston, Texas*

The hollow-fiber spacesuit water membrane evaporator (HoFi SWME) is being developed to perform the thermal control function for advanced spacesuits and spacecraft to take advantage of recent advances in micropore membrane technology in providing a robust, heat-rejection device that is less sensitive to contamination than is the sublimator. After recent contamination tests, a commercial-off-the-shelf (COTS) microporous hollow-fiber membrane was selected for prototype development as the most suitable candidate among commercial hollow-fiber evaporator alternatives. An innovative design that grouped the fiber layers into stacks,

which were separated by small spaces and packaged into a cylindrical shape, was developed into a full-scale prototype for the spacesuit application.

Vacuum chamber testing has been performed to characterize heat rejection as a function of inlet water temperature and water vapor backpressure, and to show contamination resistance to the constituents expected to be found in potable water produced by the wastewater reclamation distillation processes. Other tests showed tolerance to freezing and suitability to reject heat in a Mars pressure environment. In summary, HoFi SWME is a lightweight, compact evaporator for heat rejection

in the spacesuit that is robust, contamination-insensitive, freeze-tolerant, and able to reject the required heat of spacewalks in microgravity, lunar, and Martian environments.

The HoFi is packaged to reject 810 W of heat through 800 hours of use in a vacuum environment, and 370 W in a Mars environment. The device also eliminates free gas and dissolved gas from the coolant loop.

*This work was done by Grant Bue and Luis Trevino of Johnson Space Center; Gus Tsioulos of Wyle; Keith Mitchell of Jacobs Technology, Inc.; and Joseph Settles of Barrios. Further information is contained in a TSP (see page 1). MSC-24849-1*

## High-Power Single-Mode 2.65-μm InGaAsSb/AlInGaAsSb Diode Lasers

**This innovation is useful for targeted gas detection instruments in environmental monitoring, safety, quality control, and fundamental science applications.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

Central to the advancement of both satellite and in-situ science are improvements in continuous-wave and pulsed infrared laser systems coupled with integrated miniaturized optics and electronics, allowing for the use of powerful, single-mode light sources aboard both satellite and unmanned aerial vehicle platforms.

There is a technological gap in supplying adequate laser sources to address the mid-infrared spectral window for spectroscopic characterization of important atmospheric gases. For high-power applications between 2 to 3 μm, commercial laser technologies are unsuitable because of limitations in output power. For

instance, existing InP-based laser systems developed for fiber-based telecommunications cannot be extended to wavelengths longer than 2 μm. For emission wavelengths shorter than 3 μm, intersubband devices, such as infrared quantum cascade lasers, become inefficient due to band-offset limitations. To date, successfully demonstrated single-mode GaSb-based laser diodes emitting between 2 and 3 μm have employed lossy metal Bragg gratings for distributed-feedback coupling, which limits output power due to optical absorption.

By optimizing both the quantum well design and the grating fabrication process, index-coupled distributed-feed-

back 2.65-μm lasers capable of emitting in excess of 25 mW at room temperature have been demonstrated. Specifically, lasers at 3,777 cm<sup>-1</sup> (2.65 μm) have been realized to interact with strong absorption lines of HDO and other isotopologues of H<sub>2</sub>O. With minor modifications of the optical cavity and quantum well designs, lasers can be fabricated at any wavelength within the 2-to-3-μm spectral window with similar performance. At the time of this reporting, lasers with this output power and wavelength accuracy are not commercially available.

Monolithic ridge-waveguide GaSb lasers were fabricated that utilize second-order lateral Bragg gratings to generate